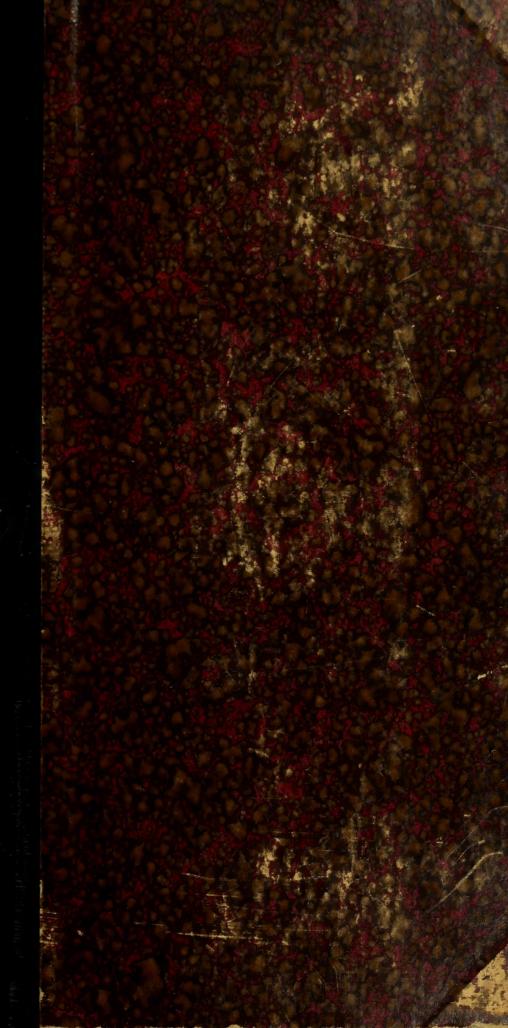
SAWYER

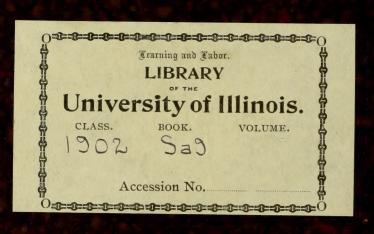
Hydrant Rental

Municipal and
Sanitary Engineering
B. S.

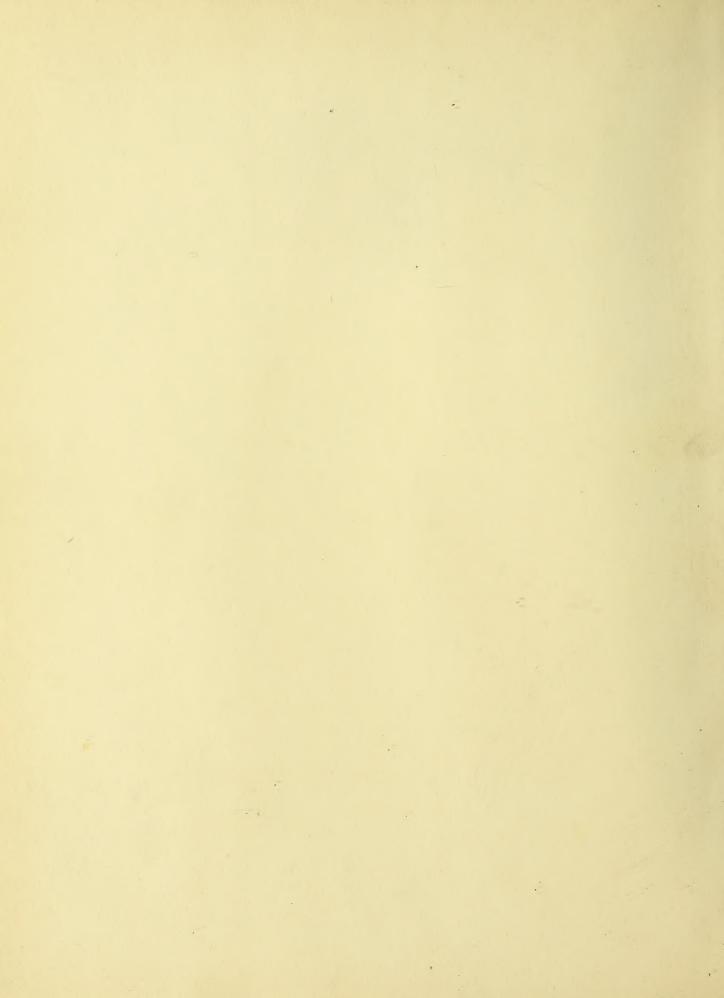
1902



UNIVERSITY OF







## HYDRANT RENTAL

BY

### DONALD HUBBARD SAWYER

# THESIS FOR DEGREE OF BACHELOR OF SCIENCE IN MUNICIPAL AND SANITARY ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1902

# HYDRANT RENTAL

YH

### DONALD HUBBARD SAWYER

THESIS FOR DEGREE OF BACHELON, OF SCHONE

COLUEGE OF ENGINEERING
UNIVERSITY OF ILLINOIS
PRESENTED JUNE 1992

### UNIVERSITY OF ILLINOIS

May 30, 1902. 190

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Donald Hubbard Sawyer

ENTITLED Hydrant Rental

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

or Bachelor of Science in Municipal and Sanitary Engineering.

affalbor

HEAD OF DEPARTMENT OF Municipal & Sanitary Engineering.

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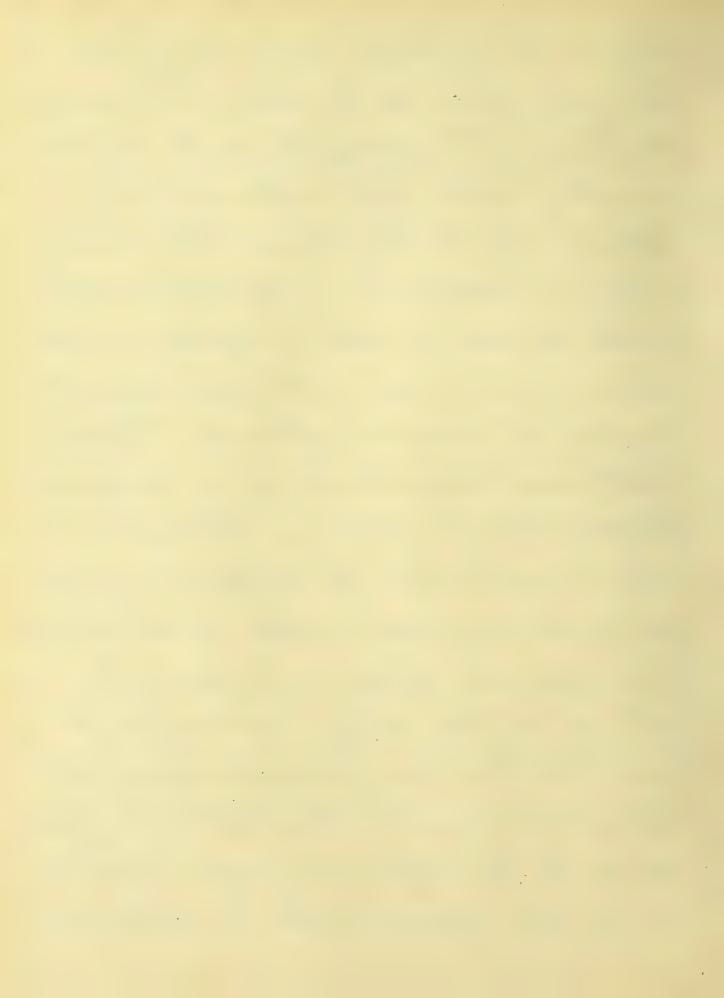
1902

# = Sydraut Brutal =

The proper charge for hydraut rental is of importance to both the private water company and the municipality paying it beties pay large sums for the fire protection rlement of water works, but so jar as the writer knows there has breu little Effort made to determine what charge for highrant rental is just. The importance of the subject is realized by considering the great number of water-works plants in existence receiving renumeration from cities for fire protection. When a water company applies for a franchise to supply a town with water, it seeks to install a large number of hydrauts on the system and to receive in return for these as large a yearly revenue as possible. In fur cases does the company itself know what a just

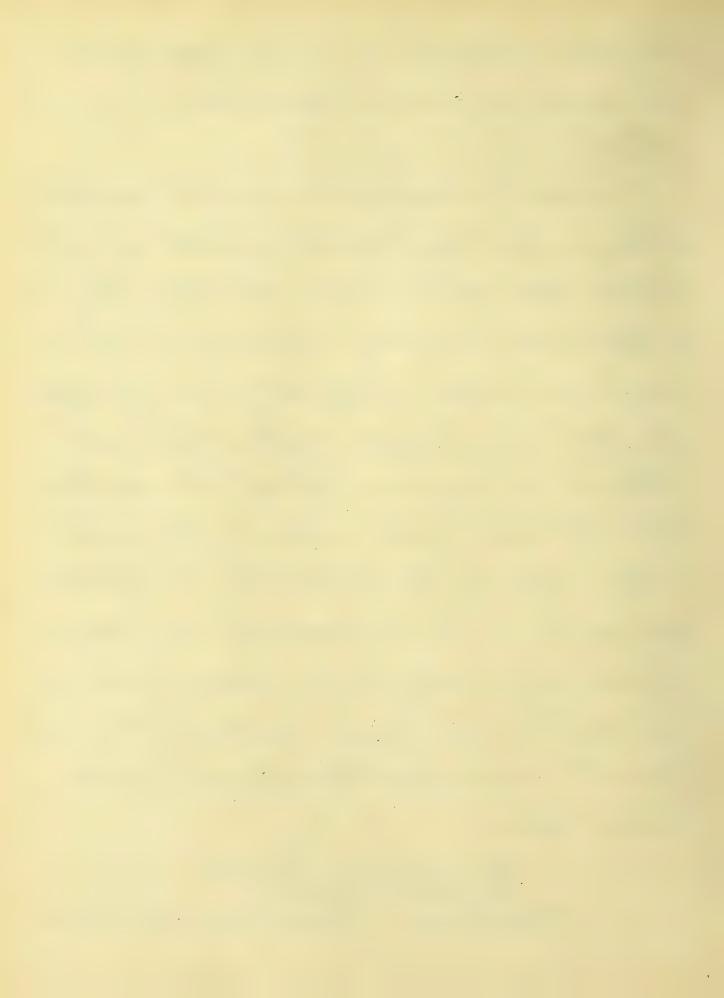
of motor water plants in william with the course UIUC

charge is, its only Vasio for such a charge bring that made in similiar localities under similiar emolitions. The ordinary tours, on the other fand, is rutirely helpless in the matter and only attempto to hold the charge down to that made in a few neighboring cities coming to their notice Is not a few cases the rental of hydrauts is made such as to Jour a bours for the water company to Eucourage the construction of the works. This is most frequently done where The city is small and the prospection receipto from other sources is not from suy, or where the development of a supply or other unfavorable condition makes the installation unusually Expensive on cases of this nature the Equitable charge is not sought but merely that which may prove outispactory to both parties to the agreement. Many water-works of hauls assume that the domestic use of water should pay for operating Expenses and that the revenue from



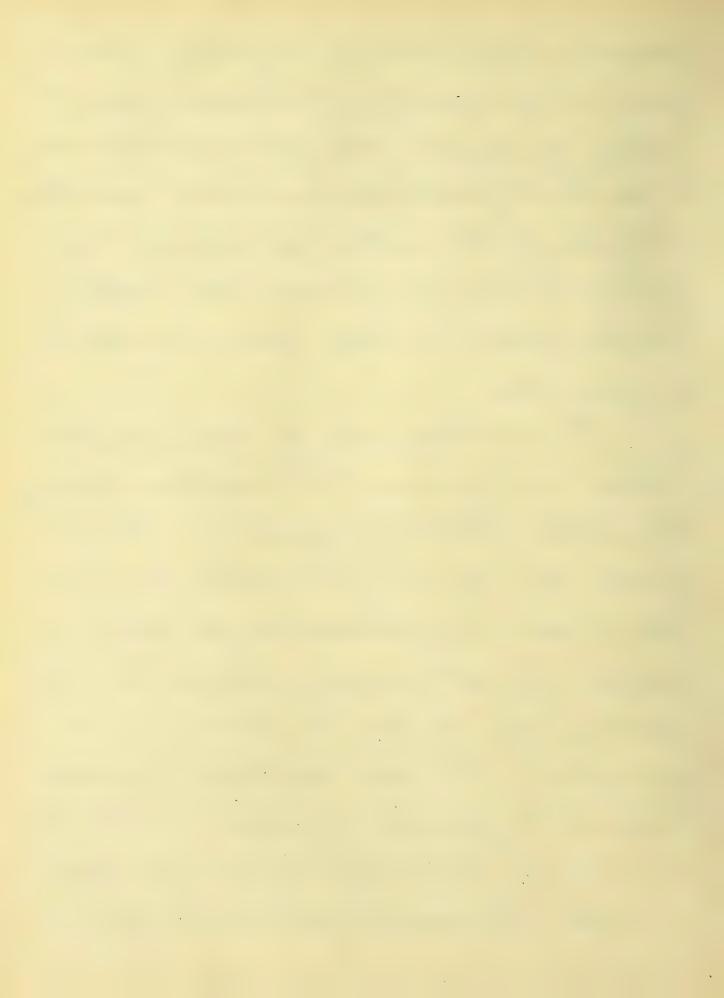
de this thesis au Effort is made to morstigate the charge which may be called Equitable and just between water-works company and city. While it is known that such charge must vary with the varying conditions of different cities, it is losed that despete the personal Equation which must Enter ruto any design and Estimate the results are close to the mean of the condition of the smaller ruland aties of the middle west. The treatment will include, (1) The usurance vate, (2) Tresent hydraut rental rates, and 3) Geess of cost of fire protection and domestic service together over domestic service alone to be reduced to a per hydraut tasis!

It was hoped to obtain from insurance

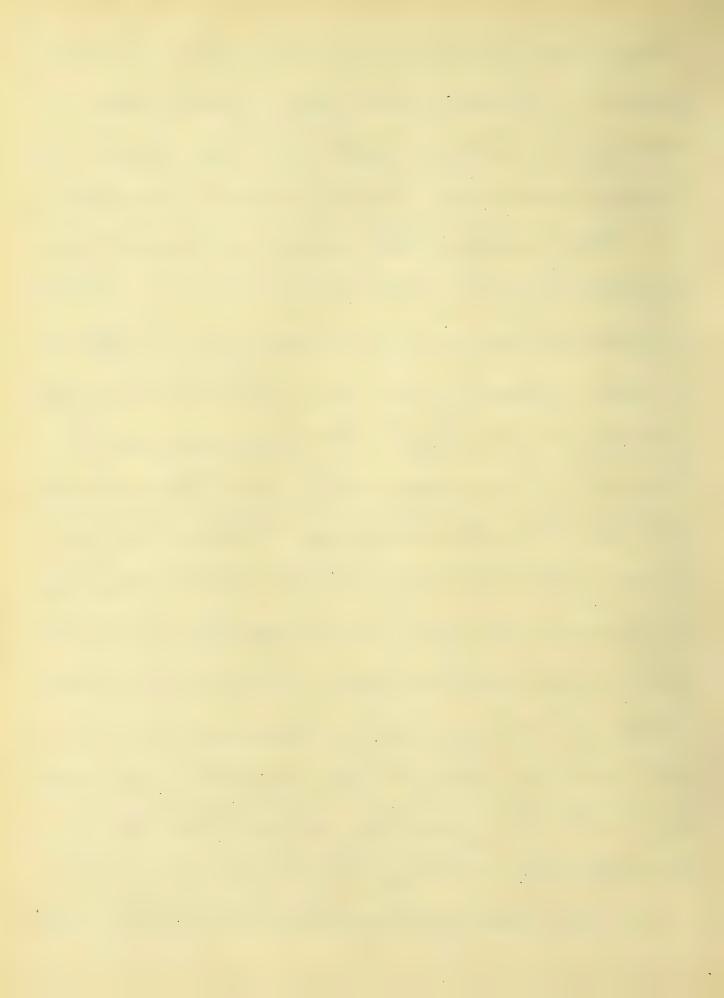


combanies data which would permit hydraul reutal and fire protection to be balanced against increase of insurance rates for improtected risks. It was thought possible that such data would allow the finding of the conditions and increased size of town when it would be Economical to install a complete septem or to change from a domestic to a fire system.

It is well known that fire insurance rates are very largely governed by the conditions attending the protection of bullings against fire However, the mere fact that - a city - has a water plant and that hy drauts are distributed over the bull-up portions does not necessarily undicale that the insurance rates are lower than those in torns not Do supplied. The value Established by mourance companies are generally arbitrary and what may be true in one city- may be no basis for comparison in another. The insurance rate depends upon the



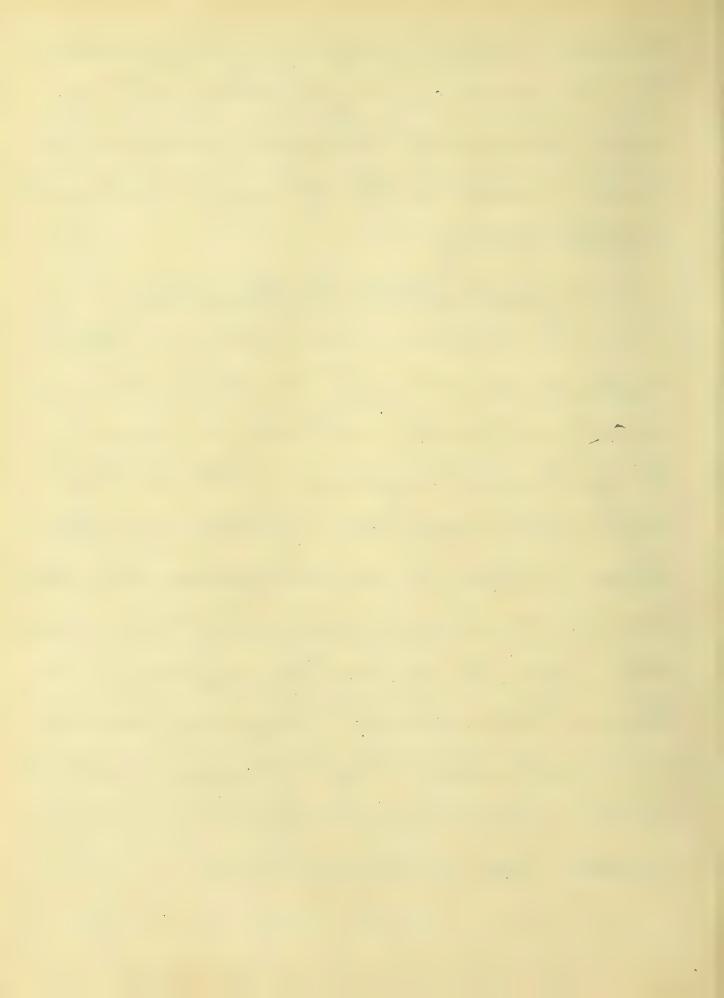
character and closeness of structures, the number and position of hydrauts, availability of water plant in case of fire, reserve supply of water, number of Firemen constantly on duty and other conditions. Dala relating to this phase of the Subject were difficult to oblain. Insurance men seem to Favr no accurate information concerning it. Breides, So many clements Enter whit that it is to comply Iwadegrah treatment. For their reasons the trarmy of mourance rates upon hydraut rental will not be further insidered; However, the Jollowing statement may be taken as true, considering its general character and that particular arcum-Stances will control to use: - when the difference belivere the annual cost of mourance of a citynot protected against fire and that of the summe aly with - fire protection is less than the corresponding annual cost of a fire system oursa domestic septem, their it is not Economical



to install a system providing fire protection.
This takes no account of the fact that alies are rapidly growing, that trater-works are designed to years in advance and that governing conditions are constantly changing.

— Present Hydraut I sutal Ratio.—

· lis fas besu said no set rules fit hypotrant reutals; and so, as might to Expected, there is no Evident relationship in the vales at present charged by water companies. I table has brown Compiled from data found in the thesis of R.C. Brown Thursely of Illinois, '97 and in the American Water-Works Menual of 1897. The cities gives are thought to be represent ation in population and conditions and sunition to this used later in this work. Etarges vary according to the franchise under which a company tolds ito rights. Thus a different charge is made for hydrauls above a certain number.



- Sark I. -

# Hydraux Rental Ralio in the Midelle West.

	City	Population	Wile of Main	Harants Hydrant Mile of Fear	City	Population Mile of	Hrd. oor Mile of Main	Hrapor Hydrant Mile of Rentalpor Main 1905
9,400 4,2 45.00 Mit Jacksmy, Jul. 300 8.8 6,500 8.9 45.00 Museutine, Ima. 12,000 10.1 26,000 8.9 45.00 Withouth, Jul. 3,000 10.0 3,200 6.4 37.50 Quentlo, Mis. 5,700 16.4 21,500 1.0 75.00 Juinay, Mis. 21,800 5.7 14,000 10.8 58.00 Animay, Mis. 21,800 4.0 5,900 7.3 60.00 Animayid, Ima. 21,800 4.0 5,900 7.3 60.00 Animayid, Ima. 21,800 4.0 2,100 10.0 56.00 Animayid, Ima. 5000 8.2 2,100 10.0 50.00 Animayid, Ima. 31,000 15.0 12,000 7.8 50.00 Manen, This. 30,200 13.7 7,500 6.8 40.00 Lemin, This. 7,300 7.7	alpena, Mich.		6:3	\$62.00	Marion, This.	8,300	10.8	38.00
6.500 10.0 35.00 Museatine, Ima. 12,000 10.1 25,000 8.9 45.00 Workerick, Inc. 3,000 10.0 3,200 6.4 37.50 Qevator Wio. 5,700 12.0 26,800 9.8 40.00 Juniay, Inc. 31,500 12.0 26,800 11.7 46.00 Juniay, Inc. 31,500 5.7 20,000 11.7 46.00 Juniayille, Mu. 21,800 4.0 3,800 8.2 50.00 Aringrick, Mu. 21,800 4.0 2,100 10.0 50.00 Aringrick, Inc. 20,000 15.0 2,100 10.0 50.00 Aringrick, Inc. 30,000 15.0 12,000 9.1 25.00 Manen, Iris. 31,000 7.0 7,500 8.8 40.00 Lenia, Iris. 3,000 7.0	an abor mich.		4.2	45.00	Mut. Jackson, Jud.	300	8.8	50.00
26,000 8.9 45.00 Workerick, Gul. 3,000 10.0 3,200 6.4 37.50 Qenitor, Mis. 5,700 16.4 21,500 7.0 75.00 British, Gul. 2,800 12.0 26,800 11.7 46.00 Jordynd, Jul. 2,300 7.1 14,000 10.8 58.00 Aringhid, Mis. 21,800 4.0 5,900 7.3 60.00 Aringhid, Ama. 500 8.0 3,800 8.2 50.00 Aringhid, Ama. 500 8.0 2,100 10.0 50.00 Aringhid, Mis. 25,000 15.0 105,000 7.8 50.00 Aringhid, Am. 31,000 105,000 7.8 50.00 Truckent, Mis. 30,200 13.7 1,500 8.8 40.00 Lewin, Mis. 31,000 7,500 8.8 40.00 Lewin, Mis. 7,300 7.7	Einleville, This.		0.01	35.00	Muscatine, Ima.	12,000	1.01	75.00
3,200 6.4 37.50 acoutto, Mio. 5,700 154 21,500 7.0 75.00 Britise, Mi. 2,800 12.0 26,800 9.8 40.00 Anina, Me. 31,500 5.7 14,000 10.8 58.00 Aringvill, Mis. 21,800 4,0 5,900 7.3 60.00 Aringvill, Ama. 500 8.0 3,800 8.2 50.00 Aringvill, Ama. 500 8.0 2,100 10.0 50.00 Aringvill, Ama. 50,000 15.0 2,100 10.0 50.00 Aringvill, Mio. 26,000 15.0 105,000 7.8 50.00 Armun, Mio. 26,000 15.0 12,000 9.1 25.00 Amun, This. 31,000 7,500 8.8 40.00 Lewis, This. 51,000 7.0	6 timbre, Ima.		6.8	45.00	Woblesville, Inf.	3,000	10.0	33.00
26,800 7.0 75.00 Portiae, Mr. 2,800 12.0 26,800 9.8 40.00 Anima, Lu. 31,500 5.7 20,000 11.7 46.00 Animapila, Mr. 21,800 4.0 5,400 7.3 60.00 Animapila, Mr. 21,800 4.0 3,800 8.2 50.00 Animapila, Mr. 21,800 8.0 2,100 10.0 50.00 Animapila, Mr. 26,000 15.0 6,400 5.8 50.00 Animapila, Jul. 30,200 15.0 12,000 9.1 25.00 Manua, This. 31,000 7,500 8.8 40.00 Lewis, This. 31,000 7,500 8.8 40.00 Lewis, This. 1,300 7.7	Countant This.	3,200	4.9	37.50	acouto. Wio.	5,700	15.4	65.00
26,800 9.8 40.00 Juinay, Sur. 31,500 5.7 20,000 11.7 46.00 Pringhild, Mrs. 21,800 4.0 14,000 10.8 58.00 Pringrild, Mrs. 21,800 4.0 5,900 7.3 60.00 Pringrild, Ama. 500 8.0 2,100 10.0 50.00 Princhmir, Miss. 26,000 15.0 6,400 5.8 50.00 Princhmir, Miss. 26,000 15.0 12,000 9.1 25.00 Maneu, This. 51,000 7,500 8.8 40.00 Lewis, This. 6,000 7.7	Council Bluffs, La.		20	75.00	Portial, Il.	2,800	12.0	42.00
20,000 11.7 46.00 Probyrd, Jul. 2,300 7.1 14,000 10.8 58.00 Aringhild, Mr. 21.800 4.0 5,400 7.3 60.00 Aringhild, Mrs. 50.0 8.0 2,100 10.0 50.00 Aringhil, Arra. 50,000 8.2 6,400 5.8 50.00 Frenchmik, Al. 30,200 13.9 105,000 7.8 50.00 Manu, This. 31,000 7.0 7,500 8.8 40.00 Lemia, This. 7,300 7.7	Danuput, Ima.		8.6	40.00	Juiney, La.	31,500	5.7	46,00
14,000 10.8 58.00 Aringfied, Mo. 21.800 4,0 5,400 7.3 60.00 Aringfied, Mo. 21.800 4,0 3,800 8.2 50.00 Aringfied, Mis. 26,000 8.2 2,100 10.0 50.00 Aringfied, Mis. 26,000 15.0 6,400 5.8 50.00 Aringfied, Jul. 31,000 12,000 9.1 25.00 Manen, This. 31,000 7,500 6.8 40.00 Lemin, This. 7,300 7.7	Eau bluir Mis.	20,000	11.7	46.00	Porkford, Sall.	2,300	7.1	40.00
5,400 7.3 60.00 Aringvill, Ama. 500 8.0 3,800 8.2 50.00 Arizalin; Mr. 18,000 8.2 2,100 10.0 50.00 Argenin, Wino. 26,000 15.0 6,400 5.8 50.00 Ferre Haule, And. 30,200 13.9 105,000 7.8 50.00 Manen, This. 51,000 7.0 7,500 8.8 40.00 Kenia, This. 7,300 7.0	For on the this.	14,000	10.8	58.00	Aringfield, Mo.	21.800	4.0	55.00
3,800 8.2 50.00 Wishing Mis. 25,000 8.2 2,100 10.0 50.00 Orne Hull, Ind. 30,200 15.0 6,400 5.8 50.00 Orne Hull, Ind. 30,200 15.0 105,000 7.8 50.00 Orne, Man. 31,000 7.0 7,500 8.8 40.00 Remis, Mis. 1,300 7.7 Manu, Mis. 1,300 7.7	Frankfut, Ind.	5,900	23	60.00	Springvill, Ina.	0000	8:0	35.00
2,100 10.0 50.00 Experim, Win. 26,000 15.0 6,400 5.8 50.00 Ferre Hult, Ind. 30,200 13.9 10.5,000 7.8 50.00 Manen, This. 51,000 7.0 7.5,000 8.8 40.00 Lewis, This. 1,300 7.1 8.8	Franklin, Ind.	3,800	8.2	50,00	Wiseling su	18,000	8	42.00
6,400 5.8 50.00 Bere Stud. St. 30,200 13.7 105,000 7.8 50.00 Byeka, New. 31,000 12,000 91 25.00 Waren, Shis. 6,000 7.0 7,500 8.8 40.00 Kenia, this. 7,300 7.7	Hushill, Ind		10.01	5000	Experior, Wio.	26,000	150	40.00
105,000 7.8 50.00 Typeta, New. 31,000 7.0 12,000 9:1 25.00 Warren, shis. 6,000 7.0 7.5 7.500 8.8 40.00 Zenia, this. 7,500 7.1	Indeposabley, my		6.8	80.00	I are stank, Sad.	30,200	13.7	40.00
8.8 40.00 Waren, shis. c,000 7.0 Mean, this. 7,300 77	Indianapolis, Ful.	100,000	2.8	50.00	Oxforka, Naw.	31,000		50.00
7,500 8.8 40.00 Lewis, this. 7,300 77	Jamesvill, Trio.	12,000	16	25.00	Warren, This.	6,000	7.0	45.00
8.00	Farting M. Mich.		8.8	40.00	Lewis, this.	1,000	7.7	37.00
					Mean			\$47.88



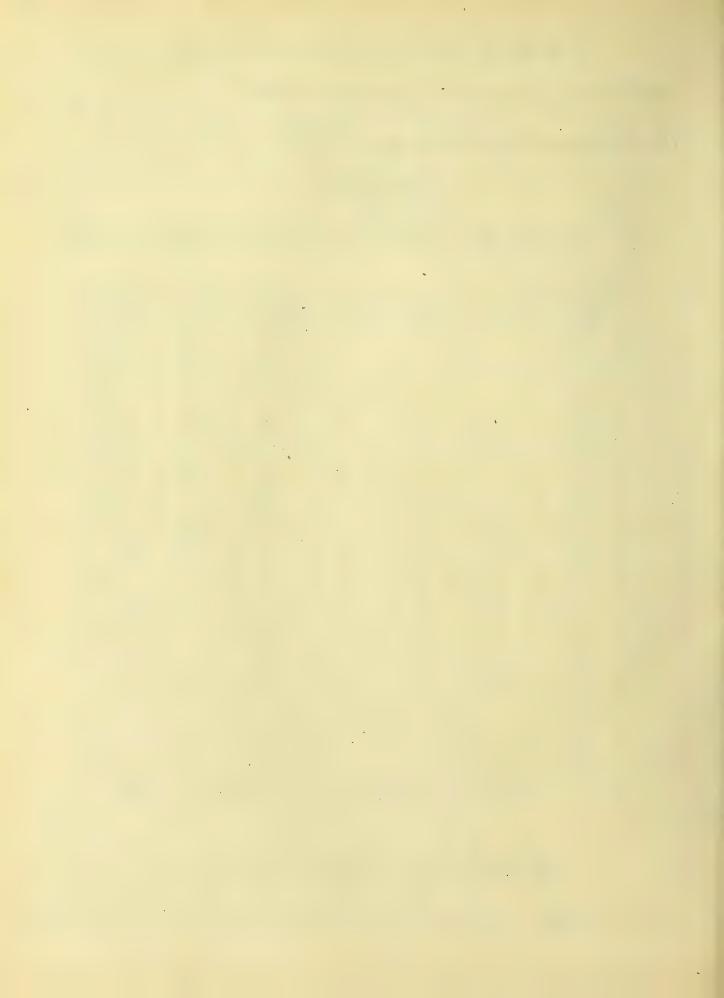
Of general idea of hydraut, ratio may be obtained from the Jollawing table compiled from the Manual of American tration-traks for 1888.

— Table Ti-

- Jable II:
The aut R cutals in the United States in 1888.

Hydrant Rate	North Western	South Western	Pacific	Total for Western	Total for Eastern	Totalin U.S.	
\$5			2	2	9	//	
12			2	2	16	18	
15					29	29	
20			4.	4	22	26	
25		/	6	6	24	30	
30	/	2	2	5	33	38	
35	/	/		2	26	28	
40	3	2	4	9	44	53	
45	/	2	/	5	27	32	
50	1.3	12	4	29	60	89	
55	3			3	60	11	
60	9	8	/	18	24	42	
65	2	4	/	7		7	
70	4	4		8			
75	12	4		16	24	40	
.80	12	4	11	20		20	
85	3	6	/	10		10	
90				3	5	7	
100	18	15	3	36	5	41	
120			/	/		/	
125		/		/		/	
150		1		/		/	
160		A		1		1	
Mean Rate = \$49.53 544							

By comparing tables-I and II a close relationship is at once noticed in the Junal means.



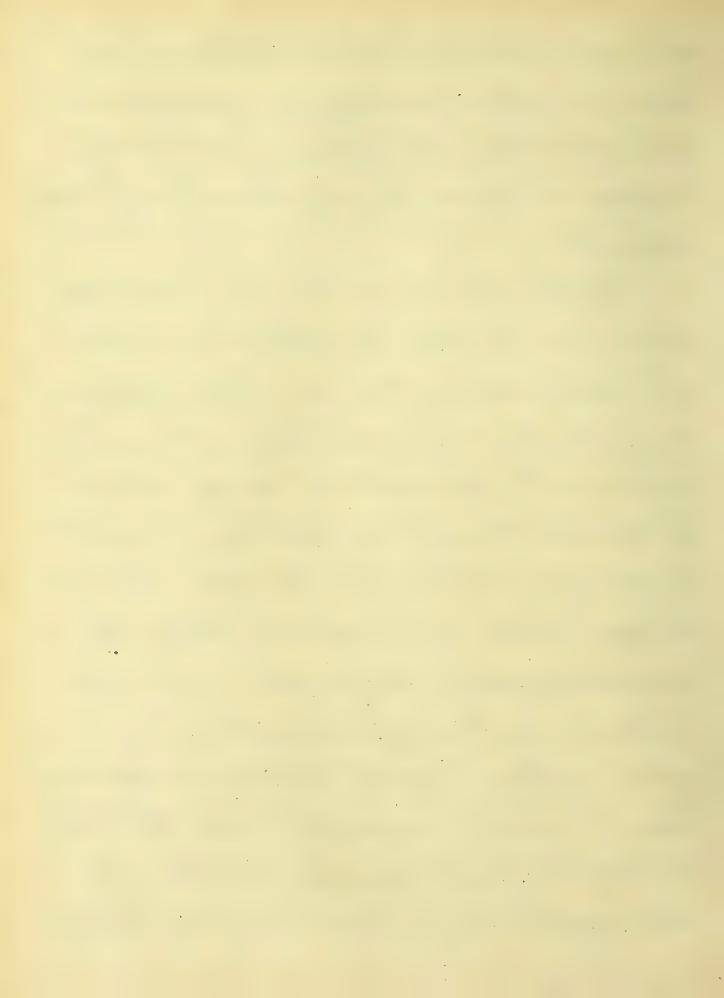
The third beat of the work - the actual diffrence in cost believes a combined fire protection and dimistic service and a domestic system almost of water-works - Jurnishes the only accurate findation upon which to tase the charge for Lydrauts. Comparison with existing rates, even after much effort has been spent in obtaining the same conditions, may give only crude and unsatisfactory results.

The purpose is b-select cities representing average conditions and to design (1) a system of

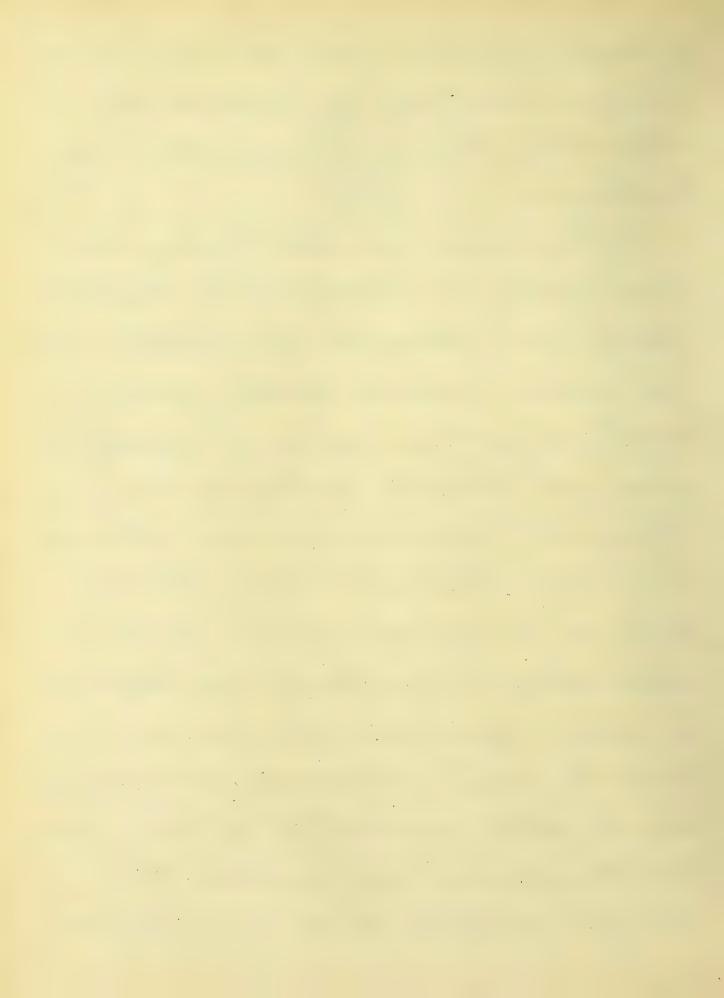


walis-works to supply dimestic demands only, and (2) a system providing fire probation as well. By obtaining the difference in cost in thise two cases the proper charpe for the reutal of hydrauts willresult.

The cities selected as Exemples are Tolono, Paylon, Daville and Strugpild, all strated in the custral part of Illinni. These are chosen as representing mean conditions in this portion of the country, as well as the vauge between the smallest size of true which may to Effected to sapport a frontable privale water plant and the largest cities when plants are likely to be controlled by frival-companies. In very fre instences is it a paying invistment for private parties to install a water-works in a lown of less than 1000 people. On the other tank the large cuty can varely afford to have to water supplied by a private company. The source

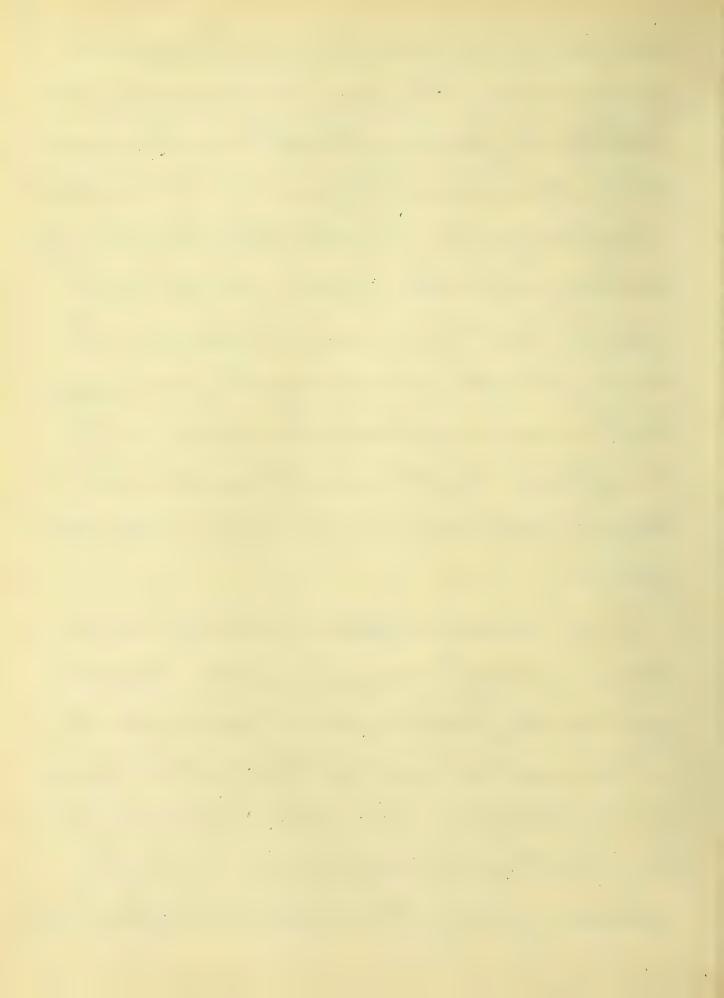


of supply of the cities considered is also repres-Entation, as the majorely of the prairie cities oblans water Either from drivers wells whear by streams. The principles upon which the designs are tased are similar. Maps of the aties used were oblamed and, knowing the local conditions as to hismess and residential districts, source of supply and probable location of hydrants. a plan of the distribution septem was made showing all valors, hy domite and specials. The siplemo as laid out are planned to be adequat for a period of wind years. In Todar to oblam the population for which to froud, the census reports for the years 1890 and 1900 for the cities considered were made use of and fine these the probable size of the city aghir twenty years The period wished was calculated. When known the per capila rate of consumption was

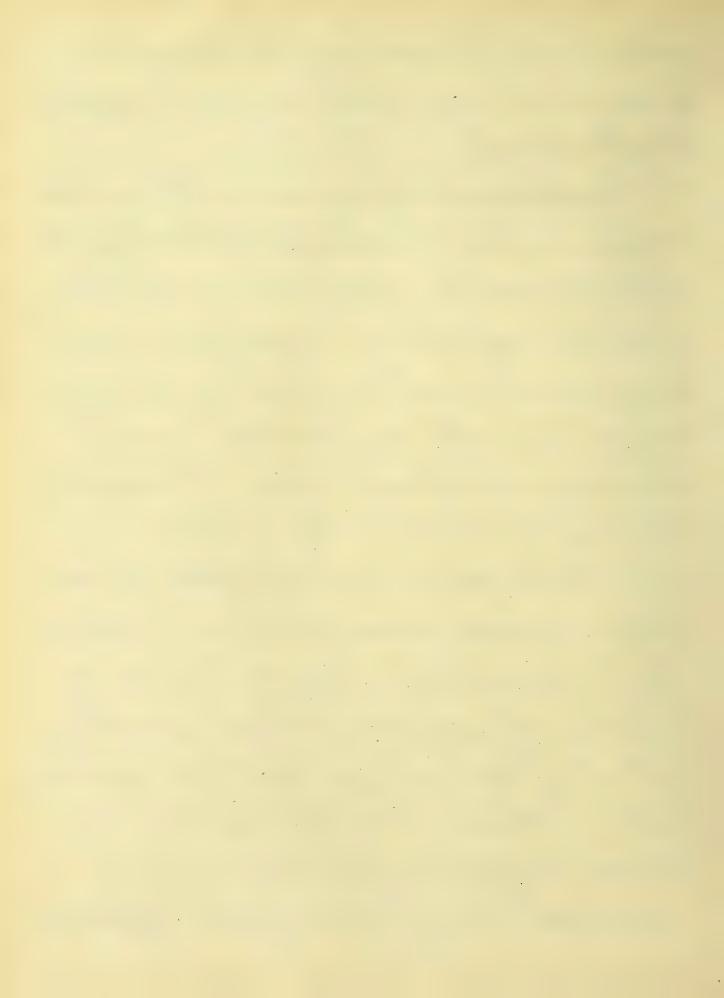


used, and 225 % of this Employed to obtain the Digr of menus. When provision was made for fire protection the governing Element was the number and sign of streams required to be concentrated at any one print. The same total length of sige line was used in both suplems, as well as an Equal number of values and specials: The Dource of Dupply was always the Dame Geept that the member of driver wells varied in the. two systems. In all cases it was desired to oblain the most renormical installation and operation:

pipe is used for the minimum size . Smaller pipe than this could be used as jar as capacity is concerned. but sizes less than this cost more per loss of metal and are cast in sections less than 17 first which materially micreased the effences of laying. When possible such an arrange-



ment is made that pumping only during the day io necessary - au Elevated reservoir Dupplying the matt draught. To determine the sign of menins in the fire systems reference was made to authorities on the subject to oblam the proper number of Sheams for Cities of various populations. 4 with pipe is used in some cases to connect dead suds of 6 inch pipe. Jary amounts of this size can also to used 4 advantage in vry small aties. Hydrants are not placed ou sizes less Hair 6 michis That the results may be relatively the same atable of prices is used throughout the Estimates. These are given his table III. page 14. That part of the Expense of laying pipe relating to Excerating, tack filling, fandling of pipe and labor in making fruits is oblemed from Westons Tables for medum digging compiled from work in Turidence R.J. The price gives for hydrauts

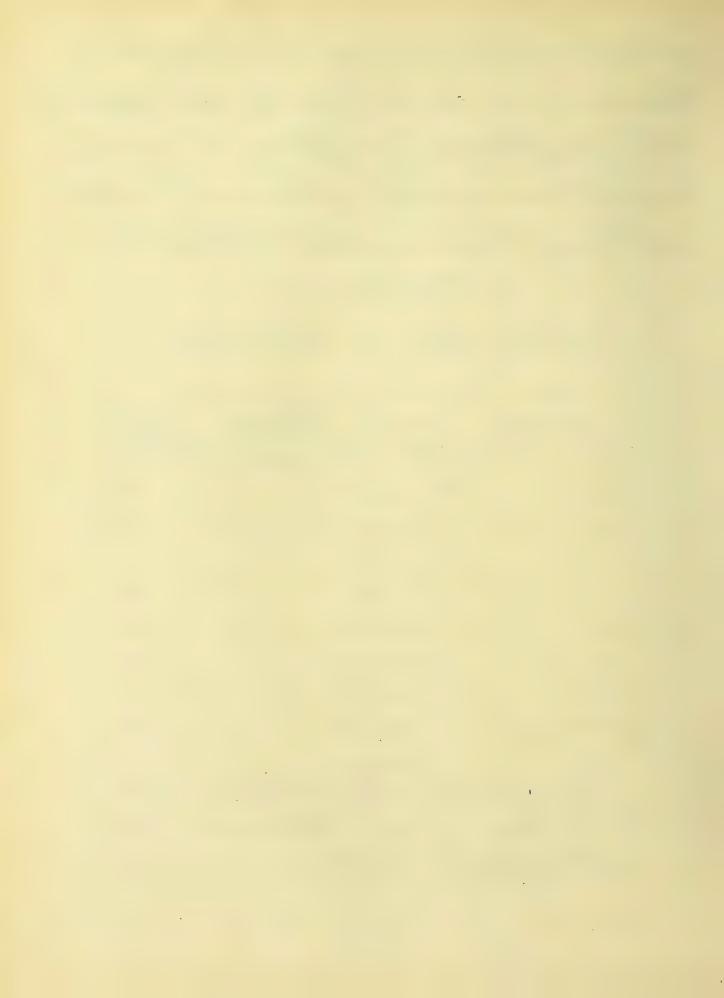


These prices were checked up with those prevailing at the present time and friend to agen very closely.

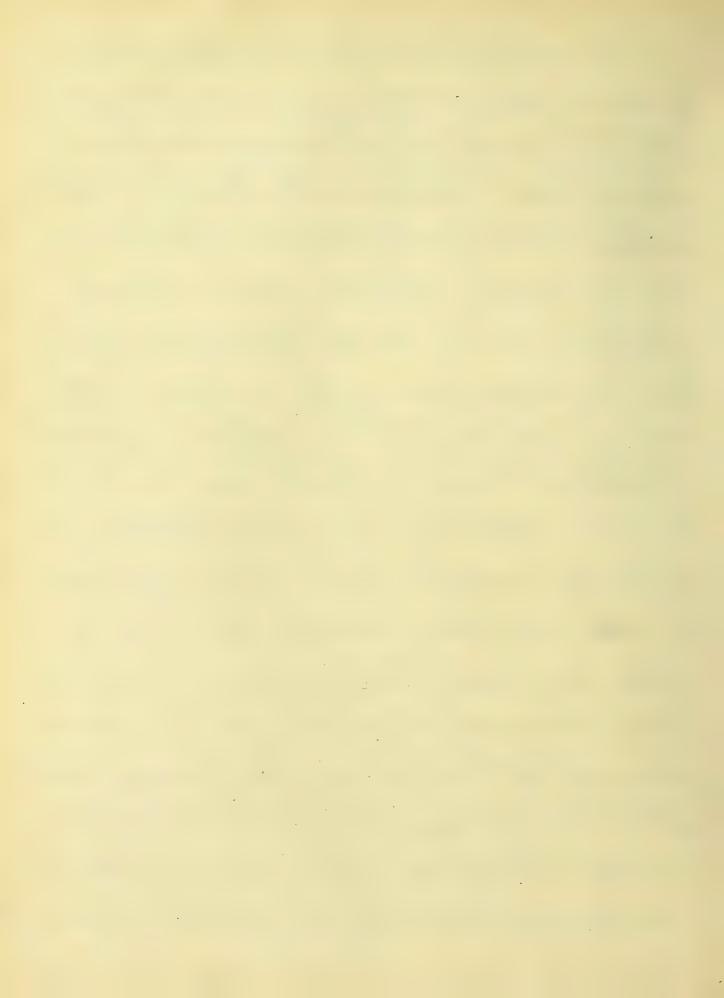
Our additional 10% is 10, " is added to the total cost to cover sugmering and contingences — Jave III:

Price Basis of Estimates

Mate	rial		Price	1	later	rial		Price
			\$5.00					\$ 26
4 "	W.	it	7.50	4 "	K	67	41	.32
6 "	· u	11	12.50	6 "	.,	t <sub>\</sub>	48	.5/
8 "	ģ5	11	19.00	8 "	0€	**	45	.72
10 "	ч	BL	25.50	10"	45	6/	4/	.98
12 "	u	ш	31.00	12"	14	ts	41	1.24
16 "	. "	(t	58.00	16"	IC	er	15	1.88
20 "	44		100.00		ď		14	3.00
24 "	15	16	150,00	24 11	"	fų	K	4.09
30 "	14	44	250,00	1				5.08
	rauls-							24.00
1			4.50					
Juli-	perpu	rud	54	Fro	ed -	) t		43/44



The cost of operation in Each system is jound by Estimating the Just w forer seguired, the the test his Libely to be reded, the who was nece stary and the ileus of labor. These count be determined with certainity but are probably as near correct in our case as another. The cost of fuel necessarily Huchialis with the amount of water pumped and the varying price of the kind used; Repairs can ruly be quessed at as it is alloyther nupossible to fortell what break w alteration may occur w by needed. Hore, as in the cost of the suplemes, an additional per cent is added for contengencies. Under the Leading Dukung Fund "will be gury the amount which, if placed annually at 5% compound interest, will provide a sum sufficient for the rebuilding of the purify plant at the sud of to years and of the distribution sipleus in 50 years. Auch a fruid as this is not always set aside by officials but there is

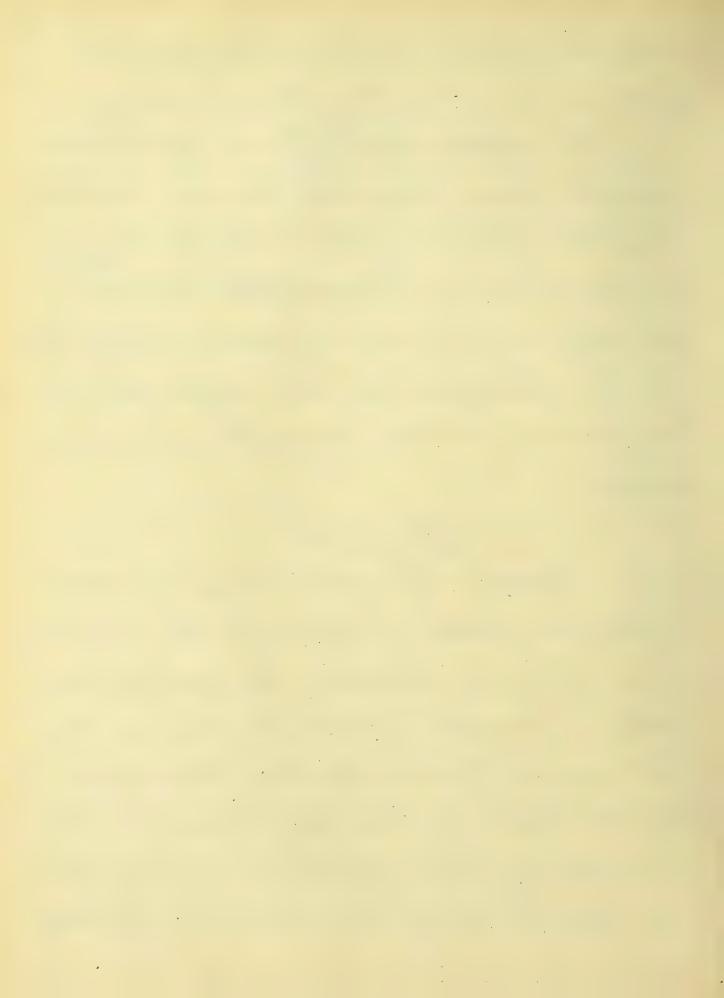


no doubt hit what in carefully operated plants if should be ballow for Juture retuilding.

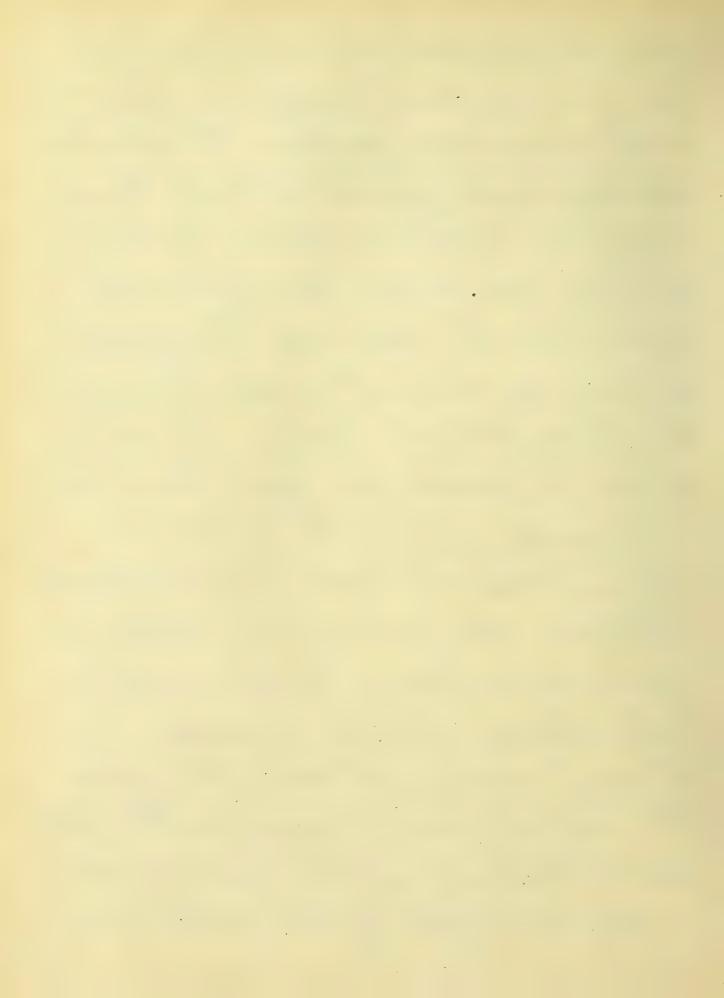
The comparison will be tased upon the sums
of the their items gives above, nemely, first cost,
if evation and sinking prod This sum will
traded to per hyparant rate and also a
with reference to the miles of menies and population
The cities for which wales works Estimates
fave brees made will now be considered in order
of sign.

- Tolour =

General: There is at present a municipal water plant in Tolono and this is used
as a tasis for the estimates. as now operated
water is pumped by means of steam deep
word pumps from a cound an 8-inch will
into an clivated wooden tank from which the
cit, supply is Araum. Primping is necessary
for only three or four hours a day for the greater



pat of the year, but this involves the building of a new fire Every time the pumps are started, which is not remonical in operation. The distributions septens was not suggestent from tours of the sage now were then hydroauto curry h to amply thout the properly assimist fire. These christs were remedied in the design used. The postulations of the tim was 902 in 1890 and 845 in 1900, this showing a sheight dicrease. The articul as laid out frovides for a Rokulation of 1000. Domestie Aptive: - The distribution system is laid out to give a suspicient supply Last hands of the win, and tallow for the small growth mentioned above. a daily per capila consumption of 60 gallons is assumed and on meins are designed to carry 275% of this. The most Economical pumping plant to install and operate was found to consist of gasoline sugnice working the deep will pumps, Each



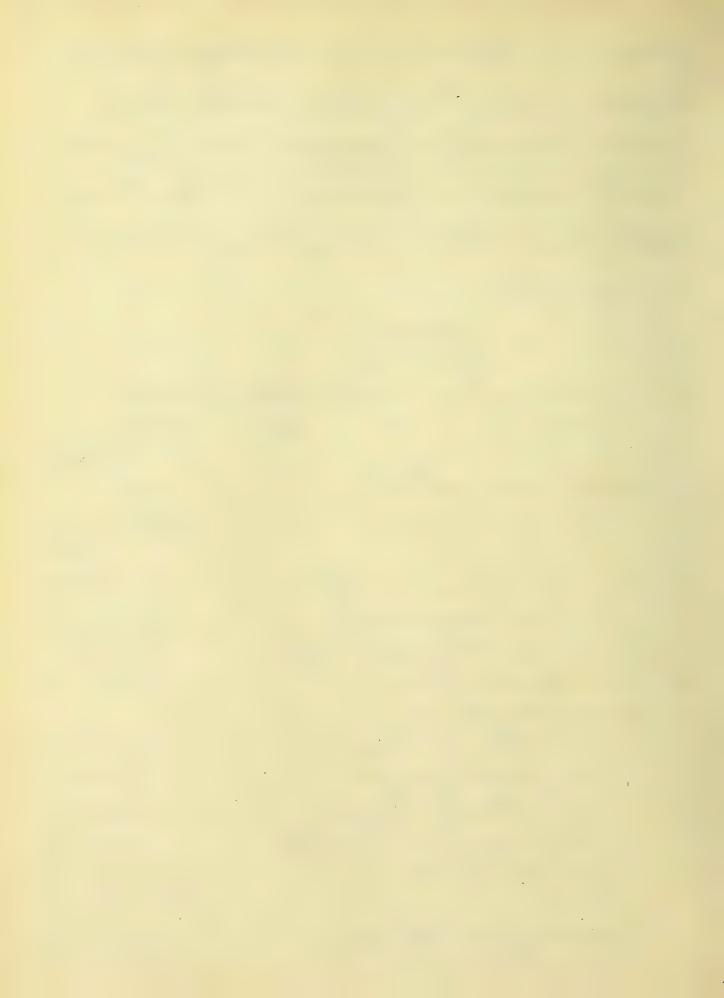
placed in a separate brick building. Halis from the wells passes to a wooden Elevated touk seated on a 40 foot masonry tower from which the city's supply is obtained. The tank is of such capacity that pumping army the day is buly necessary.

<u>Estimali</u>

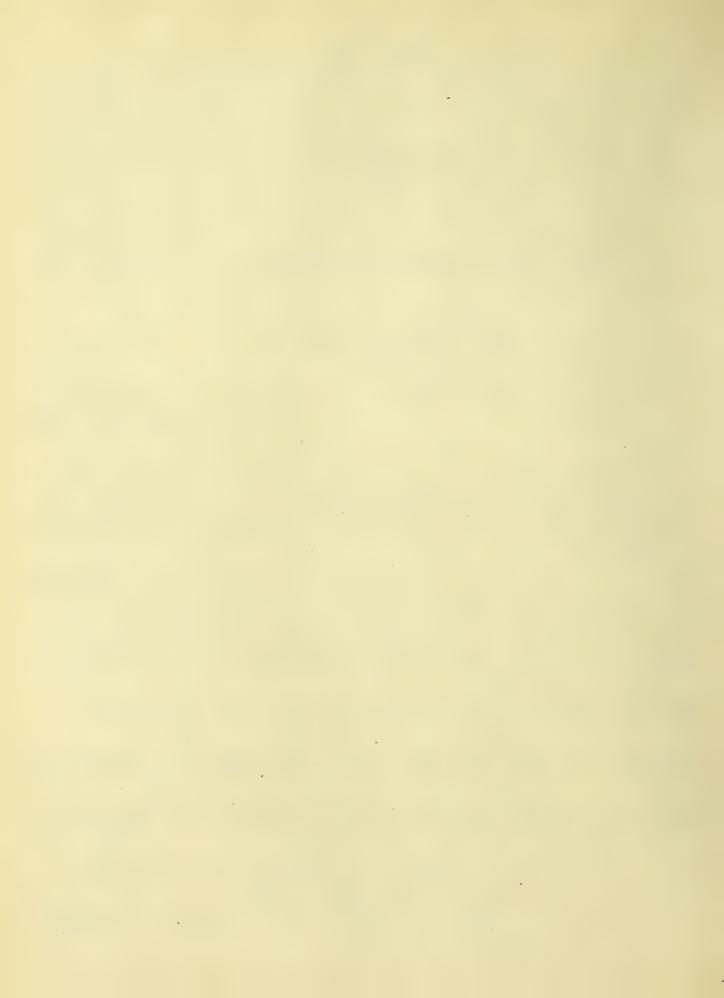
<u>First Cost</u>

13,750 July 13" pipe 6.76¢ \*3,445.00

1,710 " " 4" " @.37¢ 387.70 3,837.70 14-3" Values & 500 70.00 3-4" @ 750 22.50 92.50 1135# of Specials @ 2/2¢ 48.37 17 Valor Boxes @ 4:50 # 76.50 H,024,57 Total Cost of Distribution Splew 40' Masiny hour ( 3,000.00 n'x30' Wooden temp ) 3-8"/orlls-150' dup 1,800.00 3. Dup will pumps 1,800.00 3-8 19 Fasolins Engines 600-00 3-8 × 10' Brick Fin for bulding 300.00 Tiping and Valors \$ 11,679.57 Total Cost of Solecie \$12,847.52



Operation
V 800 Gallous of Gasoline @ 12 d
Attendant
Click
Arpairs and Lapplies \$ 336.00 350.00 150.00 100.00 936.00 add 10% Total annual Operating Expense 93.60 \$1.029.60 Distribution Desteus Ormpring Plant Total 10.93 264.51 # 275.44 length of pipe and position of valors and specials is the Dame as in the Amestic Septem. Hydrauts are located about 700 first apart so that the suture bun is Julies froteted agains fire. The mains an designed to carry the maximum dimestre supply as well as Jour 200 gallon fire streams. Some your with pipe is used to come of the Endo of six wich meins in order to Jurther arculation and prevent stainant water. The source of supply



is the same as in the former service although the number of wells is of course increased. The Elevated tank is placed higher than before in weder to Juruish adequate Fire pressure. Sto capacity - is also mereased to that it will hold the usual mights consumption and also one hours fire demand In this way the attendant is gurs pluty of true to slait the sugines and commence purpuy water. It is thought that this explent is the most seminal that can be used in attes muder these conditions. The tent is of such sign that it is not practicable to make it of wood and Leuces selis Tised.

## Estimali

#\frac{\frac





= Paylon =

Friend: - The city of Parton is quite similar to to invite tocation and source of supply. The potulation increased from 1,187 in 1890 ho 3036 in 1900 and a semining this growth to be constant it was calculated that the population with, years Lence would be about 6,000. a standpipe in the fresent splein acts as a reservoir but juster than this nothing is known concurring the plant.

is designed for an average consumptions of 60 gallons percapite and a maximum of this The semmical pumping plant was found to comprise pumping from wells by means of deep well pumps operated by gasoline sugines. Set in aparah pump houses: Wahr from the wells passes diedly has clerated tank from which the city Dupply is drawn. This tank is of such apacity.



as I supply the nights consumption without jumpmy. The lank is set 50 Fret about the ground, high Eurogh Loupphy all the Juliures in the alig: - Estimah -First Cost 7 3 ppe 6.76 ¢ 9,795.50 37,675 Fork 1,875 " 600.50 6" " @.5/ 7000 " 382.50 8" " @.72 270.00 375 " 10" " 0.98 75 " 73.50 \$11,122.00 29-3"Va loss 0.500 140.00 @ 750 3-4" 77.50 2-6" 2/200 25.00 7 - 8" 0 1900 38.00 07500 1 - 10" 25.50 256.00 2163# of Specials @ 2/rd 54.07 36 Valva Bres @ 450 167.00 Total ast of Distribution Leptens \$11,594.07 Masny trover 50') 8,500.00 Such tank n'x 60' 6-8" Wills 3,600.00 6 - Der bwell pumps 3,600.00 6-10/1 Fastini Tuymes 1,500.00 6-8'X10' Brick Fromp Buldwip 600.00



\$400.00 Piping and Valors 29,794.07 Trial Cost of Depters 2,979.40 \$32,773.47 17,000 Gallow of Gasoline @ 126
Applies \$1,440.00 Aupphio 800.00 attendant 400.00 Clerks 500.00 Irpano 200.00 \$2,740.00 Red 10% 274.00 Total annual Operating Expense 3,014.00 Distribution Septem Franking Plant Total 54.48 635.37 \$ 689.85 Fire and Domestic Septem: - The distribution sypline is designed I carry the Amestic supply as welf as 6- 200 yallow fin streams. The lungthof pipe line, and locations of pipe, valves and Specials is the same as in the case of the domestic service Hydrauts are placed about 700 fert

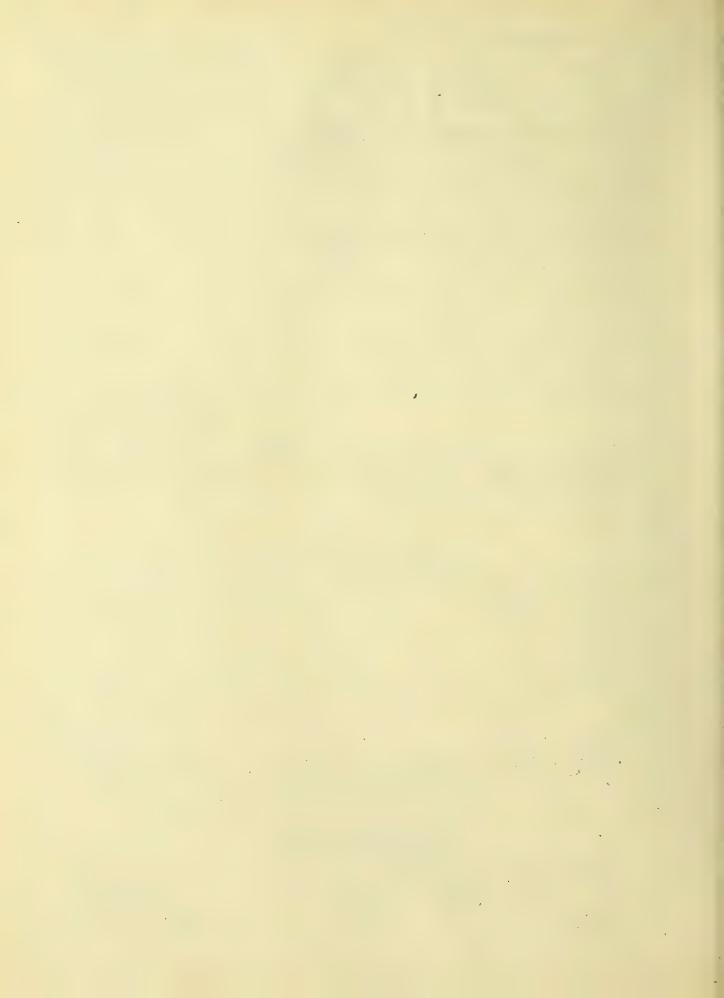


plant. a material change is made in the purifying plant, new salated by the fire Element. In a city of this sign it is not grasible to brild an elevated reservoir to told water to to used for fine purposes. If suce a surface reservoir is Employed tolding about one faunt of a day armestic and fine supply. This demands that are Engineer to orduly at all times to vaise the pressure where a fine occurs. Steam power is substituted for gasoline:

First Cost \$960.00 3,000 fut of 4' pipe @.32¢ 18,450 " " 6" " @.51¢ 9.409.50 " " 8" @.77¢ 11,417.00 15,85.0 n n/0" 2,940.00 3,000 " @.98¢ " 17" 558.00 " @1.74¢ 450 25,279.50 0750 10-4" Valors 75.00 @ /250 275.00 18-6" @ 1900 1-8" 19.00 5-10" @ 7550 127.50 2-12" @3100 67.00 508.50



\$1,425.00 57 Hydraulo @ 7500 15,499# of Specials @ 2/26 387.47 36 Valve Byles @ 450 167.00 \$27,762.47 Total Cost of Distribution Leptens Covered Freeworn - 44,000 Fal. Cap. 6,000.00 8-8" Wells 4.800.00 Tumping Station Building 5,000.00 1,750,000 Fal. Tim Finis 1.100.00 600,000 Gal. Tump 700.00 6. Durp well pumps 3,600.00 no H Boles @ 1200 2,400.00 Tiping Valves Ele 2,000.00 \$53,362.47 Engineering and Contingences 10% 5, 336.24 \$ 58,698,71 1,800 his n cral 6th, 20 \$ 1,500.00 Prepairs 300.00 Eterk 500.00 #3,400.00 add 10% 340.00 \$3,740.00 Total Annual Operating Expense Distribution Supliers
Franking Flour 130.36 927.99 \$1,058.35



## = Danille =

Usice From. The great difference in population the cely of Danville Rigers From the two previous cities in Durce on supply. The distribution sypline gious in R. P. Brown's thesis is used as the tasis for the distribution septem Leve. His was designed in 1897 For a period of hornly year Level for a population 17 83,000. as the air is satuated on a river ites natural Hat it Should Nouvil supply, from it. Cin musual Frahin of the Existing plant is a 42" X 408' Stand pipe which als merely as a release valve on the septem.

Domestic Apleus: - Wothing new fresents itself in the case of the distribution expline. as there is a large selectrical plant in Damille Junishing power at reasonable vates it was dicided to utilize this to special to the pumps. It has power pumps in duplicate are graved to a single motor. These sempstake their supply from the river and pump it diedly into



the mains By an internation arrangement they may be made to respond to the differences in pressure and consequently out, occasional attention will be needed to operate them. No reservoir is required as its junction is julyilled by a dawn across the river.

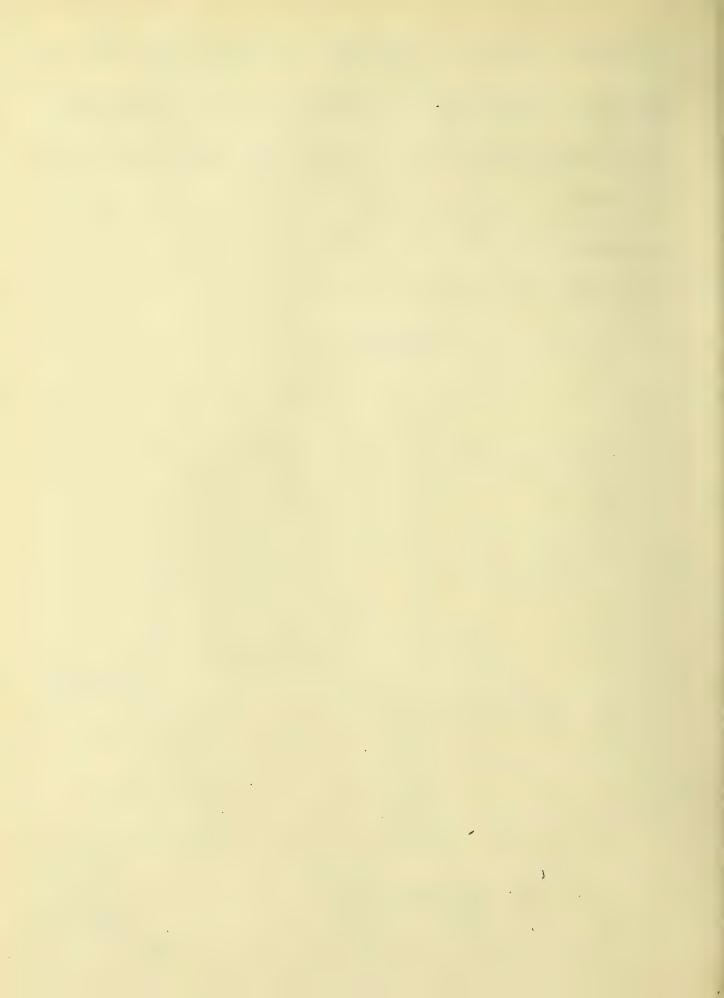
## Estimah First Cost

89,005 frit of 3"pipe @. 26 Py3,141.30 8,725 2,742.00 0.32 " 6" 1,550.00 3,040 0.5/ . 8" 5,061.60 7.030 .. @.72 " 10" " Q.98 1,489.60 1,570 " 12" 7,564.00 " @1.74 6,100 ·· @1.56 3,170.00 .. 14" 2,000 44,718.90

75-3" Talves @ 50 375.00 3-4" " @ 750 22.50 " @1950 37.50 3-6" 3-8" @1900 76.00 Ħ 3-15" @3/00 93.00 \*\*

17,786# of Specials @ 1/rd 88 Valur Bres @ 450 Total Cost of Distribution Aplens 604.00 309.15 396.00

\$46,046.05



\$1,000.00 Dam across niver 2-2,500,000 Fallow pour pumps 4,000.00 Electric motor 1,360.00 Tump Amse, 3,000.00 Hal Cost of Splem Engineering and Continuous 10% \$55,386.05 \$60,294.65 3,000.00 Electur power @6¢ per XW tertendant 350.00 Supplies 300.00 Troais 600.00 Apperintendent and blinks 2,50 0.00 6,750.00 add 10% 675.00 Total Annual Operating appense \$7,425.00 Distribution Deplement Function Heart Total 21632 446.94 \$663.76 Fin and Domestic Spleis: - The length of merins,

Fin and Domistic Aplens: - The length of mains, their location and that of all the values and specials is the Dame as in the Armestic service. The munber of Lydrands in the existing splene is too few and so an increase is made which places their about



700 firt apart. The mains an designed I supply leis fin streams braides the water for dimestic consumption. Is cities of this size it is Essential that fire pressure, or available at all times and where so much power is necessary it is generally cononny to operate an independent plant. Fruce steam ustallation is used and high dut, fumps to Dupply on water auteresting from the noticed is that the cost of relative purisabour the cost of coal, but Hat sleam installation is nove Expension Han Electric molors and that the labor ileur is much higher in the case of the steam plant.

Estrinah-

First Cost

2,980 firt of 4" pipe @.32 953.60 2,540 " " 6" " @.51 47,095.40 87,540 . 8" 4,980 · @ .72 3,585.60 16,150 " 10" 15,827.00 1 @ 98 2,670 " 12" " @124 3,310.80 .. 16" 8,100 " @1.88 15,728.00

\$81,000.40



5-4" Valors @ 72
3-8" " @ 1900 57.00  12-10" " 0 250 306.00  2-17" " 0 3/00 62.00  3-16" " 0 580 174.00  160 Hydrauls @ 2500 4,000.00  55,600 # of Specials @ 2/20 396.00  88 Valur Bryes & 450 396.00  Total Cost of Distribution Splin #88, 210.40  Dam across river 1,000.00  1-4,000.00 Gal. Hyd Duly Property 5,760.00  480 The Briles @ 1300 5,760.00  Grup Hose 450 5,760.00
12-10" " @ 3/00 306.00  2-17" " @ 3/00 62.00  3-16" " @ 5800 174.00  160 Aydrauls @ 2500 4,000.00  55,600 # of Specials @ 2/20 4,000.00  88 Value Boyles @ 450 4,000.00  Jotal Cost of Distribution Aplies \$88,710.40  Dam across river 1,000.00  7-4,000.000 Gal. High Dul. Jungs 70,000.00  480 Por Birles @ 1200 5,760.00  Gump Hose 4,500.00  4,500.00
2-17" @ 3/00  3-16" @ 58 00 17 4.00  160 Aydrauls @ 2500 4,000.00  55,600 # of Specials @ 2/24 1,390.00  88 Value Brycs @ 450 396.00  Total Cost of Distribution Applies \$88,710.40  Dain across river 1,000.00  7-4,000.000 Gal. Hy bulg Trufes 70,000.00  480 Por Briles @ 1200 5,760.00  Grup Hose 4,500.00
3-16" " © 58° 174.00  160 Hydrauls @ 25° 4,000.00  55,600 # 3 Specials @ 21/24 1,390.00  88 Value Bries @ 450 396.00  Total Cost of Distribution Applies #88,210.40  Dam across river 1,000.00  7-4,000.000 Gal Hydr Dul Frufer 70,000.00  480 The Briles @ 1200 5,760.00  Grup Hose 4,500.00
#1,424.00 160 Hydrauls @ 2500 4,000.00 55,600 # of Specials @ 2/24 88 Valur Bryes @ 450 396.00  Total Cost of Distribution Applies #88,210.40 Dam across river 1,000.00 7-4,000.000 Gal Hydrauls Fruits 70,000.00 480 17 of Briles @ 1500 Grup Hose 4,500.00 #1,9470.40
160 Aydrauls @ 2500  55,600 # of Specials @ 2/29
55,600 # of Specials @ 2/150 1,390.00  88 Valur Bries @ 450 396.00  Total Cost of Distribution Applies 88,210.40  Dans across river 1,000.00  7-4,000.000 Gal. High Duly Thurps 70,000.00  480 TP of Briles @ 1500 5,760.00  Group Hose 4,500.00
Joles Cost of Distribution Splin *88, 2 10. 40  Dans across river 1,000.00  7-4,000.000 Gal. High Duly Frufer 80,000.00  480 Por Briles @ 1500  Group Hose  4,500.00  \$1,9,470.40
Joles Cost of Distribution Splin *88, 2 10. 40  Dans across river 1,000.00  7-4,000.000 Gal. High Duly Frufer 80,000.00  480 Por Briles @ 1500  Group Hose  4,500.00  \$1,9,470.40
Dam aeross river 1,000.00  7-4,000.000 Gal. High Duly Grup 70,000.00  480 / For Briles @ 1500  5,760.00  4,500.00  1,9470.40
7-4,000.000 Gal. High Duly Grups 70,000.00 480 / For Briles @ 1500 5,760.00 Grup Hose 4,500.00 \$119,470.40
Fing Anse 4.500.00
Fing Anse 4.500.00
P/19,470,40
Sugmering and Continuencies 10% 11,947,04 Total Costor Septum \$131,417,44
Total Cost of Septem \$131, 417.44
Operation
7,000 lines of cral @ 125 \$7,500.00 Supplies 300.00
Fépairo 500.00
Asperintendent 7,500.00
Eugnieus 1,800.00
Friemen 1,200.00
8,800.00
XX 1070
Total Annual Operation Expense \$9,680.00



Distributions Applies
Primping Plant
Total

#414.82 1,595.97 #27,010.79

## = Apring Jield =

This city to the largest sign Leve considered for the wasmitted, as tas bern stated before, very from atres of this class are supplied by private companies. The Pasis of design for the distribution suptem was an old map of the city showing the location of all manns and highrants. This design was ucreased to Julfill the requirements of a city of 35,000 people Springfield oblains ils water fringalleries near the Saugamen rust some distance Junithe city: Fra city of its sign here are a very small number of hydrauts.

Domestic Aptens: - The meins carrying the water from the Donner of Dupply to the city are necessarily large in order to keep the loss of Lead



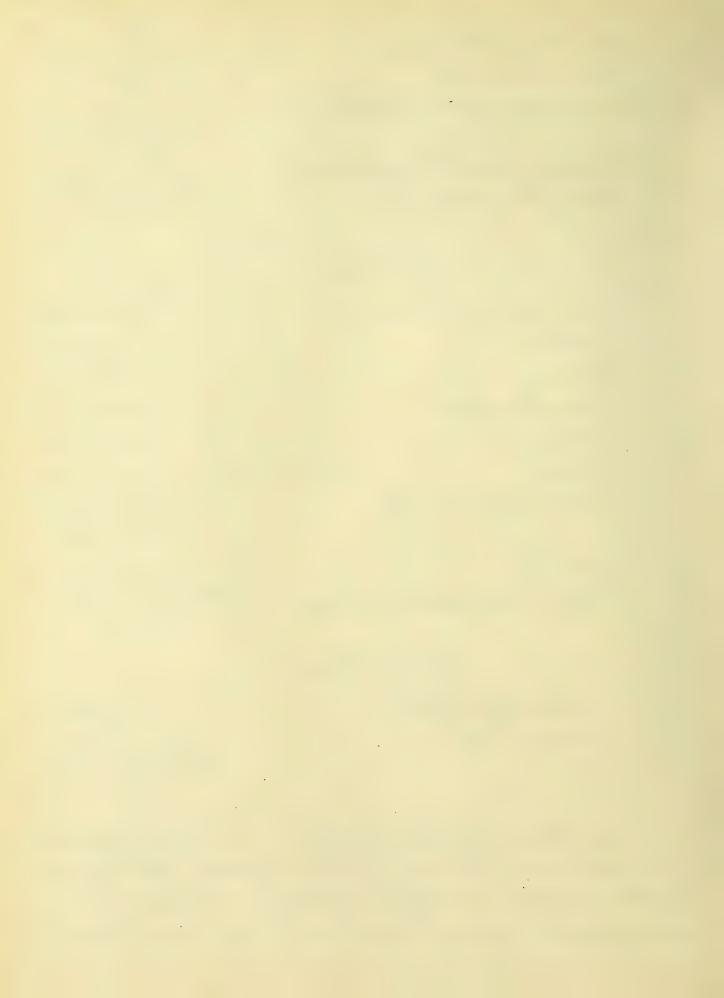
small Sleam is used at the purpury station asit Junishes the most remonical power. Estimali First Cost 112,900 feet of 3" pipe @ 76 49,354.00 . 4" " 31,300 10,016.00 @.3V .. 6" 2700 1,377.00 0.51 .. 8" 1,900 @.72 1,368.00 "/0" 784.00 800 @.98 1/2" " 992.00 @1.24 800 6,800 " 70" " W, HOO. OO @3.00 @HO9 86,380.80 21,140 " M" " \$150,671.80 114-3" alers @ 500 570.00 @ 750 24-4" 180.00 @/250 17.50 1-6" į t 1-8" @1900 19.00 1-10" @ 7500 25.50 (1 @/0000 400.00 4-20" 150.00 1- 24" @ 15000 1,357.00 77,000# of Specials @ 2/rf 550.00 145 Talva Boyes @ 450 652.50 Total Cost of Distribution Aplies 153,131.30 17,000.00

Y-3, 000, oor Gallon Thigh Delly Fruits 1370 H of Bikes @ 17 50

15,840.00



Pump House Building Pikning Valors Ele-Developing walir Supply \$6,000.00 4,000.00 10,000.00 #201,071.30 Eugineering and Contengenceis 15% 30,160.69 \$731,731,99 Peratron\_ \$4,500.00 4,500 los of cral @ 100 500.00 Prpairs 800.00 Inperintendent 2,000.00 Lugneers 2,000.00 Firemen 3,000.00 Clerks, Inspectors Ele 4.000.00 16,800.00 add 10% 1,680.00 Total annual Operating Expense \$18,480.00 Distribution September Frank Frankring Plant 780.18 7,740.00 \$2,960.18 Fire and Domestic Instead: - The length of marins their location and that is all the valors and specials is the same as in the domestic seplem. Apparents are placed about 700 firt apart - this bring much closer



Have on the Existing system. The main are designed to supply twilor v50 gallon Fire streams bisides the supply for domestic surposes. The only change in the sumping plant our the former sistem is the viere ased capacity.

Estrinali-

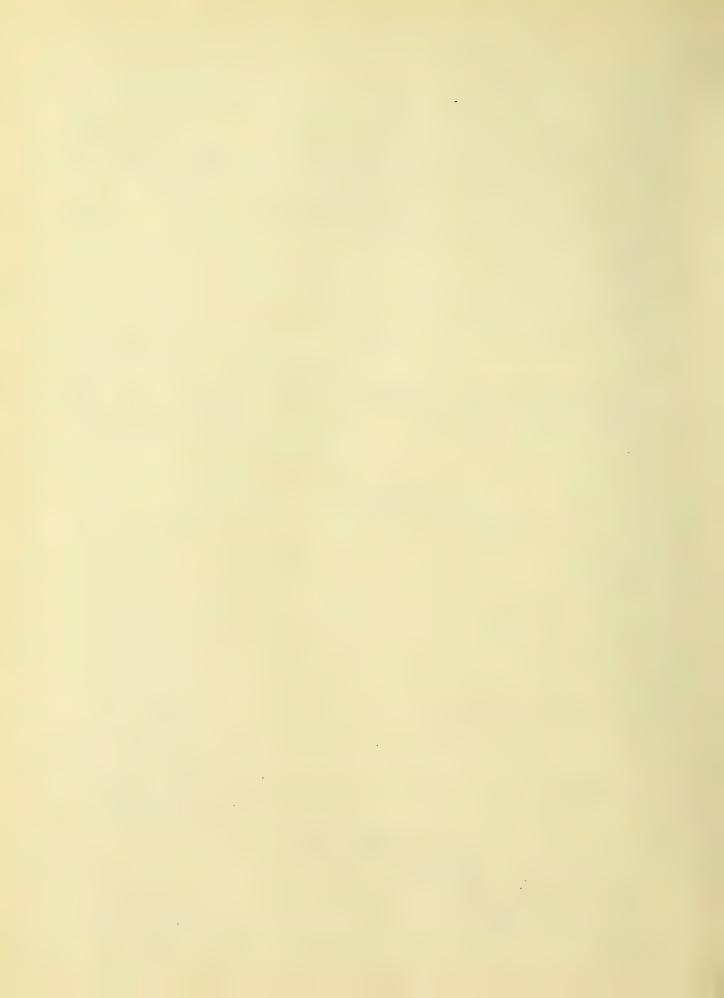
First Cost Fort of 4" pipe 8.37 107,000 57,070.00 @5/ 21,600 . 8" 15,557.00 @.72 " 10" 15,000 · @98 14,700.00 " 19" 4,300 @1.24 5,332.00 2,700 " 16" @ 188 5,076.00 2,000 .. 30" 6,000.00 @.300 6,800 " " " " " @4.09 27,812.00 ..30" 21,170 · @594125,452.80

\$ 257,840.80

6-4"7	alv	14070	45.00
103-6"	r	@ /400	1,287.50
40-8"	It	@ 1900	380.00
7-10"		@ 2550	178.50
3-19"	e	@ 3/00	93.00
1-16"	•	Q 5800	58.00
1-20"		@/0000	100.00
4-24".	62	@15000	600.00



1-30" Taior @ 100'-# 450.00 アングーー そんけっていい ログロー 6,37(100) 13 Hos # 5 Spelines Erlyt 7,335.00 145 Vave By 24"-604.00 total ost of Listulating the seems Py60, 170.30 3-3,000,000 The low high two; from is 18.000.00 185017-0, Prino 21750 14.000.00 im No HINZ 3,000.00 Juling Caurs Sec\_ 5,000.00 Lintroping Trens Luspen 15,000.00 333, 750.30 Total Cost of Depters 50,000.79 # 120,000 in Operation 6,000 knoon cral @ 100 \$6,000.00 Inpplies 550.00 Repairs 900.00 Superintendent 2,000.00 Jugineers 2,000.00 Fremer 3,000.00 Clerks, suspectors ste 4,000.00 18,450.00 Tedd 10% 1.8 45.00 Distriction Applier Ormpius Clant \$ ro, 295.00 1,746,59 3554.13 \$4.800.72



## Dummary

are shown is Table. IV and I

Jable IV. Jives statistics relating to hyanu !.
The column Leaded "Afgermatis per mile of main gurs
a mean of about 7.4. This and should very nearly
with that is a sing plants.

Marin this Hydraute-

City	Population ir 120 years	Miles of Mains	Number of Hydrants	Hydrants per 1000 of Pop.	Hydrants per Mile of Main
Tolour.	,,000	2.74	2.1	21	7.7
Paylon.	6,000	7.72	57	9.5	7.4
Danville	13,000	12.23	160	6	7.2
Spring! a	35,000	33.77	75.5	7.3	7.3

Table I presents the final results of the calculations. Column 4 is the difference between 5 and 3 and includes all the amount added for ingine inf and intergences. To obtain column 7



Column 6 was considered as placed at 67, intenst.

Column 17 is the sum of 7, 9 and 11. The sinking

and in columns 10 and 11, as Isfore suplement,

provides to annual sum which, it placed at

5% compound intenst, will fir means to rebuild

the company plant in writing years and the distribut
ion septem in Jeffy years.

7/2 hydraub per mile and \$50.00 per hydraut

in reach, the Dame to the water company as 13 his trants per mile and \$300 as his draut, and a

circus of the De per hyairant tased when see hydrant

For sach 400 fect of main is Es wiralut to a hydraut

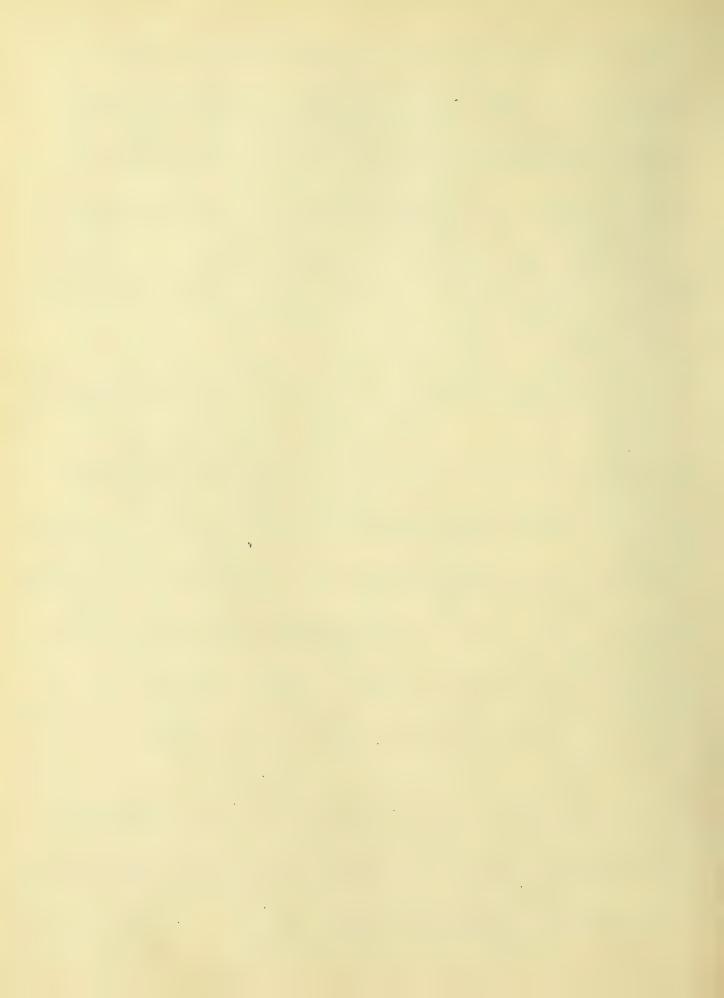
change of the with -7/2 hydrauts & the mile. This

Sement or the design must be text in mind in

making comparisons of historial rentals in dif-

firent ates.

Amust be remember a too that yeessive cost of construction, which operating expenses will increase the allowable hudrant charge.



Jall I

Estimate Costs and Issuthing Hydraut Poutal

	14	Cost	Per 1000 Prople			1,736.36	441.65		340.K		5.K.50	
	13	Hearly PerMiss Main				451.09	343.76		35703		31989	
	12	Initial Karly Additional Kearly Cost Total Kearly Cost Cost Int. 6%, Operation Sinking Fund per Per Mile Per Hydrant Hydrant Total Per Total Per Hydrant Main Propple			58.80		Ho.49		16:84		50.73	
	11				4	17.01	6.47		8.42		14.	
	10	Kearly	Sinking	Total	175.44	53393	689,85	1,058,35	663.16	p.c/c.1	7,962.18	11,4500 4,800.72
	0	tional stion Per Hyd.			7	123.00	11.74		14.29		7.17	
	9	Addi	Opera	Total	1,029.60	1,737:00	3,014,00	3740.00	1475.00	9,680,00	18,480.00	20,245.00
	~	Tearly Int. 69, Oric Hydrant			2, 0,	1/.90		27.78			35.90	
	9	hitial Cost per Hydrant			176371	17847.22 61521 36.91 102960 17544 17.31 58.86 451.09 1,236.26 23.773.47 37.773.47 454.83 27.78 3,014.00 689.85 6.47 46.49 343.76 441.65		440.00 76.40 14.39 8.42 48.91 35203 340.8		598.38 35.90 15,480.00 7.17 7,962.18 7.21 50.73 319,87 379.30		
	5	Total ?sst		148470	15,766.89	33,773.47	16.869'35	60,914,65	43,707,04 131,417,54	131, 131.99	383,818.59	
	4	Cost of Pumping Plant			8,817.95	18,09×4	04.871,15 YO.40	30,936, W	14,898.60	43,207.04	78,000.67	
2	3	Kind Cost of of Jistribution System System		4,04,57	7074.45	11.574.07	Lhidlla	46,076.05	88,210.40	1. 153,731.30	Frd. 205, 145:30 118,013,14	
	N	Kind of System		Ä	£x.1.	ż	GKJ.	7	9. 4. N.	77	Str As.	
			City		4.1		Ġ.	nation	d'anville		Springfield	



## - Conclusions

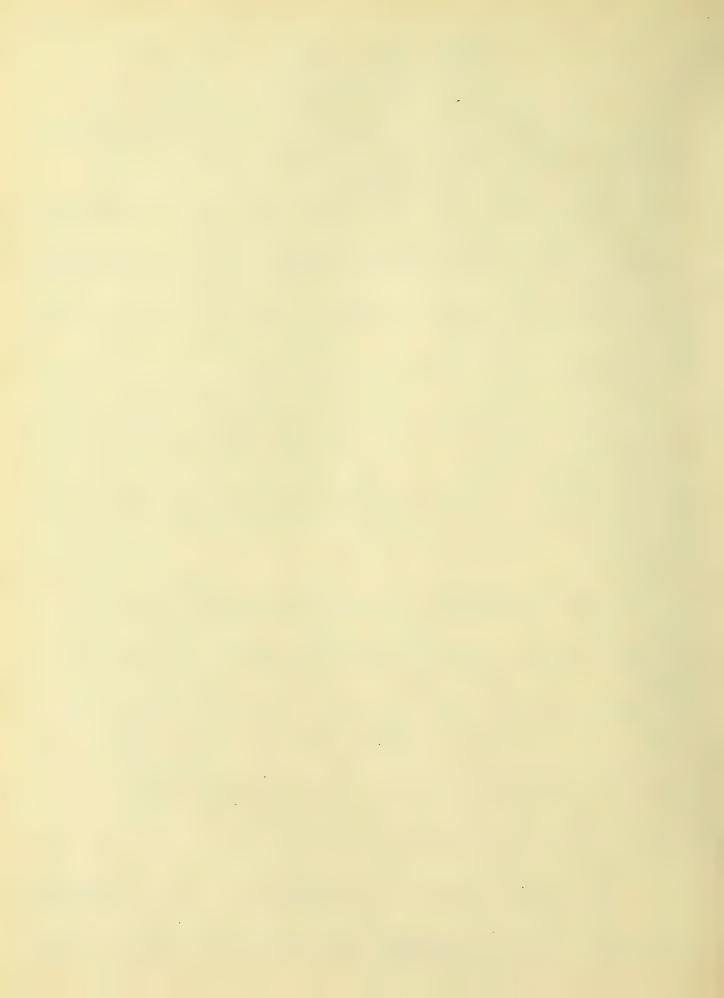
The results in the last three columns of table I show some interesting relationships.

In column 12 is James the Final & Trinale of the reason wall had sand charge trucker the conditions presented. It is to be appeared that this car of must be higher in cities in sing of our and

with-the same number of heterants ber mile the rine relation will of course bold in whome 13 as in column 1'r, and this fimiliarity may be world.

By an instation of column 14 it is seen that the cost away franches the cost is quite uniform and Lence it may be assumed that for cities lauger than ..., or the hy isant ost ser 1000 per see when I was an auch almost constant one

The prices used in the Estimal write checked up with thise at present prevailing in the middle



west. I wever, Even if these varied considerably the comparison wanted not be materially in fluenced as the cost - it amestic septem itself forms a my land. part of the fire weldmeste septem. a comparison of the mean hydrants . rate formed in table. I and II and those deduced in table I shows a remarkable or milianly. It is seen that the may rate charged in the prairie erales is nearly the rune as Hat was for the War Crowly and these two in turn were a most space, with the main of Commen Was twee V. The similarly- in the latter comparison count to accounted for is before mentioned, hydrant rates are arbitrarily established and Lence it may be said that this agreement is accidental. I mally, it is very Fortimah for both the water-wares company wit the minicipality - that the ordinary high rant rental charge accords to crosely, with that which fas bern found to be rational.



This remarkable Hat vates clarged for a long time, Established on no seemingty valinal fasis should eque sociosein with the estimated cost.

